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ABSTRACT

The CHEMATH course at Edmonds Community College integrates instruction in algebra and chemistry. The course emphasizes problem-solving techniques and relies on active learning through the use of structured group process techniques. CHEMATH is team taught by science and math faculty and is intended primarily for students planning to major in science, math, or engineering, but who have a poor background in math and science. Students completing CHEMATH 105/110 receive the credit equivalent of both Chemistry 105 and Mathematics 110. The focus on small-group problem-solving skills allows students to learn to use each other as resources; to communicate and describe problems; to learn to take responsibility for their own learning; and to build support systems. This report consists primarily of presentation overheads describing the program, and includes sample comments by participating faculty and students; course syllabi for CHEMATH 105/110, Chemistry 105, and Mathematics 110; and a sample quiz, group word problem set, lab exercise, and homework problem set. (PAA)

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CHEMATH:

A LEARNING COMMUNITY IN SCIENCE AND MATH

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&

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Edmonds Community College

CHEMATH:

A LEARNING COMMUNITY
IN SCIENCE AND MATH

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WHY CHEMATH?

- Better problem solving skills
- Need for more majors
- Reduce attrition
- Help students see connections between subjects
- Increase participation of women and minorities
- Develop students' sense of community

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WHO ARE THE STUDENTS?

- ★ Want to major in science, math or engineering
- ★ Even mix of life science/health professions & physical science/engineering
- ★ Poor background in math and science
- ★ Ages 18 - 45, typical of community college range
- ★ Even numbers of men and women
- ★ Broad range of intellectual ability

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WHAT IS CHEMATH?

- ◆ Integrates algebra & chemistry
- ◆ Prepares students for science, math and engineering classes
- ◆ Emphasizes problem solving techniques
- ◆ Minimizes traditional lecture
- ◆ Relies on active learning using structured group processes

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TRADITIONAL STRUCTURE

9am

Intermediate
algebra

10am

Prep chem

INTEGRATED STRUCTURE

9-11

Chemath

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WHY GROUPS?

- ▶ Learn to use each other as resources
- ▶ Learn to communicate and describe problems
- ▶ Learn to take responsibility for own learning
- ▶ Build support systems
- ▶ Unlearn successful high school strategy

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TYPICAL WEEK

Monday	Tuesday	Wednesday	Thursday	Friday
Math lecture	Group quiz	Math lecture	College Bowl	Lab exercises
	Chem lecture			
Jigsaw		Yes/no problem set	Chem lecture	

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THE STUDENTS SPEAK:

"I found out even the A students make mistakes."

"What are we doing now, chemistry or math?"

"Hey! The same process works for math as chemistry!"

"Great time - - if I'd have had this kind of class earlier it would have made my life very different."

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CHALLENGES

- Convincing your colleagues
- Selling your administration
- Covering the material
- Scheduling
- Special problems of small departments

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FROM THE FACULTY:

"Choose your partner carefully. You both have to be beyond paranoia."

"Students become more involved because they see us involved."

"You have to be awfully flexible, able to go with the flow of any day."

"I never realized teaching was so lonely. It's a lot of fun to work with a colleague."

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CHEMISTRY 105 OUTLINE

I MATTER AND ENERGY (Chapt. 2)

- a. physical and chemical properties and changes
- b. classification of matter
- c. matter and energy

II HOW TO SOLVE CHEMISTRY PROBLEMS I (Chapt. 3)

- a. the metric system
- b. dimensional analysis
- c. significant figures
- d. density

III HOW TO SOLVE CHEMISTRY PROBLEMS II (Chapt. 4)

- a. algebra vs. dimensional analysis
- b. metric conversions

←————→ EXAM 1

IV ATOMIC THEORY AND THE PERIODIC TABLE: THE BEGINNING (Chapt. 5)

- a. Dalton's theory
- b. atomic structure
- c. the periodic table

V ATOMIC THEORY AND THE PERIODIC TABLE: A MODERN VIEW (Chapt. 6)

- a. the Bohr model vs. the quantum mechanical model
- b. electron configurations
- c. periodic trends

VI CHEMICAL FORMULA PROBLEMS (Chapt. 7)

- a. formulas with polyatomic ions
- b. the mole
- c. Avogadro's number
- d. empirical formulas

←————→ EXAM 2

VII CHEMICAL REACTIONS AND EQUATIONS (Chapt. 8)

- a. balancing equations
- b. types of reactions

IX QUANTITY RELATIONSHIPS IN CHEMICAL REACTIONS (Chapt. 9)

- a. mass calculations
- b. percent yield
- c. limiting reactants

←————→ EXAM 3

X INORGANIC NOMENCLATURE (Chapt. 12)

- a. compounds with two nonmetals
- b. metal-nonmetal compounds

Syllabus

CHEMATH 105/110

INSTRUCTORS: David Chalif (ALD 235, 771-1626)
Mary OBrien (ALD 222, 771-1641)

TEXTS: Intermediate Algebra for College Students, 3rd ed., by Jerome E. Kaufmann
(Solutions Manual optional)

Introduction to Chemical Principles, 5th ed., by Edward I. Peters

OFFICE HOURS: Chalif: 7:30 to 7:50 a.m. daily; 1:00 to 1:40 p.m. MTWTh or by appointment
OBrien: 11:00 to 11:50 a.m. MTWTh; 2:00 to 2:50 p.m. W or by appointment

CLASS ORGANIZATION:

The purpose of studying mathematics and chemistry together is to emphasize the relationship between mathematics and chemistry, to improve your ability to solve problems, particularly word problems, and to enhance your understanding of both subjects. Some other purposes are to improve your study skills, to teach you the importance of thinking and studying with other students in the class, and to increase your independence as a learner.

To achieve the purposes listed above, this class will include several activities perhaps not encountered in a standard math or chemistry class. Emphasis will be placed on working in small groups. You will find that the efforts you make in this group work will pay dividends in future chemistry and math classes.

There will be three 100 point exams for each class. There will be a 150 point comprehensive final exam in each class. In addition, there will be seven quizzes that will always include both math and chemistry. Since participation with your colleagues is such an important part of the learning in this class, attendance is required. More than four absences will result in failure in both classes.

You are registered for a 10 credit block of classes. You may not audit or withdraw from one class without doing the same for the other. Any change in your registration status for these classes should be discussed with one of the instructors.

CLASS GRADING:

All quizzes will be a combination of chemistry and math. Your total quiz score will be the same for each class. Of the seven quizzes, the two lowest will be dropped. Separate exams will be given in each class, so therefore it is possible that you will earn a different grade for Math 110 than for Chem 105.

FINAL EXAM DATES:

The final exam for chemistry is on Wednesday, December 12, 1990 from 8 a.m. to 9:50 a.m. The final exam for math is on Monday, December 10 from 8 a.m. to 9:50 a.m.

MATH 110 OUTLINE

Chapter 1 Basic Concepts and Properties (Review, refer to as necessary)

Chapter 2 Equations and Inequalities

Chapter 3 Polynomials

Test 1

Chapter 4 Rational Expressions

Chapter 5 Exponents and Radicals

Test 2

Chapter 6 Quadratic Equations

Chapter 7 Equations in Two Variable and Graphing

Test 3

Chapter 9 (9.1-9.3) Systems of Equations

Chapter 10 (10.3) Logarithms

MATH 110 GRADING

3 exams	= 300 pts.
Final Exam	= 150 pts.
Chemath quizzes	= 100 pts.
Chemath group work and homework	= 150 pts.
TOTAL POINTS	= 700 pts.

CHEM 105 GRADING

3 exams	= 300 pts.
Final Exam	= 150 pts.
Chemath quizzes	= 100 pts.
Chemath group work and homework	= 150 pts.
TOTAL POINTS	= 700 pts.

The grading is as follows:

PERCENT OF TOTAL POINTS	GRADE
94%-100%	4.0
90%-93%	3.7
87%-89%	3.3
83%-86%	3.0
80%-82%	2.7
77%-79%	2.3
73%-76%	2.0
70%-72%	1.7

(Below 70% or missing more than four classes 0.0)

CHEMATH
Group Sheet 6

Grams, Moles, and Avogadro's Number

Objective 1: To be able to convert grams to moles and moles to grams for elements and compounds

Part A: Converting grams to moles

1. If you have 6.0 g of carbon, how moles of carbon do you have?
2. If you have 394 g of gold, how many moles of gold do you have?
3. If you have 9.0 g of water, how many moles of water do you have?
4. If you have 45 g of aluminum hydroxide, how many moles of aluminum hydroxide do you have?
5. If you have 0.47 g of calcium phosphate, how many moles of calcium phosphate do you have?
6. If you have 15.7 g of benzene, C_6H_6 , how many moles of benzene do you have?

Part B: Converting moles to grams

1. If you have 3.0 moles of gold, how many grams of gold do you have?
2. If you have 0.25 moles of water, how many grams of water do you have?
3. If you have 3.62 moles of iron, how many grams of iron do you have?
4. If you have 5.06 moles of sodium carbonate, how many grams of sodium carbonate do you have?
5. If you have 0.75 moles of arsenic, how many grams of arsenic do you have?
6. If you have 0.05 moles of sugar, $C_{12}H_{22}O_{11}$, how many grams of sugar do you have?

CHEMATH
Group Sheet 6

Grams, Moles, and Avogadro's Number

Objective 2: To be able to convert grams to number of atoms, molecules, or formula units and to be able to convert moles to number of atoms, molecules, or formula units.

Part A: Converting grams to number of things

1. If you have 6.0 g of magnesium, how many magnesium atoms do you have?
2. If you have 36 g of water, how many water molecules do you have?
3. If you have 65.2 g of potassium nitrate, how many formula units of potassium nitrate do you have?
4. If you have 472.8 g of magnesium phosphate, how many formula units of magnesium phosphate do you have?
5. If you have 0.50 g of uranium, how many uranium atoms do you have?

Part B: Converting moles to number of things

1. If you have .50 moles of gold, how many gold atoms do you have?
2. If you have 3.0 moles of water, how many water molecules do you have?
3. If you have 7.42 moles of aluminum sulfate, how many formula units do you have?
4. If you have 0.78 moles of benzene, C_6H_6 , how many molecules of benzene do you have?
5. If you have 0.035 moles of uranium, how many uranium atoms do you have?

CHEMATH
Group Sheet 6

Grams, Moles, and Avogadro's Number

Objective 3: To be able to convert the number of atoms, molecules, or formula units to grams and to be able to convert the number of atoms, molecules, or formula units to moles.

Part A: Converting number of things to grams

1. If you have 3.01×10^{23} atoms of zinc, how many grams of zinc do you have?
2. If you have 7.35×10^{25} molecules of water, how many grams of water do you have?
3. If you have 2.70×10^{22} formula units of sodium hydroxide, how many grams of sodium hydroxide do you have?
4. If you have 8.29×10^{35} atoms of lead, how many grams of lead do you have?
5. If you have 5.70×10^{23} molecules of sugar, $C_{12}H_{22}O_{11}$, how many grams of sugar do you have?

Part B: Converting number of things to moles.

1. If you have 4.36×10^{23} atoms of lead, how many moles of lead atoms do you have?
2. If you have 7.86×10^{24} molecules of water, how many moles of water do you have?
3. If you have 3.99×10^{19} formula units of calcium hydroxide, how many moles of calcium hydroxide do you have?
4. If you have 1.78×10^{20} formula units of aluminum carbonate, how many moles of aluminum carbonate do you have?
5. If you have 3.09×10^{26} molecules of carbon dioxide, CO_2 , how many moles of carbon dioxide do you have?

CHEMATH
Group Sheet 11

Sample
Group Project Set

1. With the recent news that calcium deficiencies in many women's diets may contribute to the development of osteoporosis, the use of dietary calcium supplements has become increasingly common. Many of these calcium supplements consist of nothing more than calcium carbonate. When a calcium carbonate tablet is ingested, it dissolves by reacting with stomach acid, which contains hydrochloric acid, HCl. The equation for the reaction is:
 $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$ What mass of HCl is required to react with a tablet containing 500. mg of calcium carbonate?

2. Solve the following equation and express your answers to 3 significant digits:

$$(2.15 \times 10^4)x^2 + (3.60 \times 10^5)x = 82000$$

3. An experiment that led to the foundation of a whole new field of chemistry involved the formation of urea, $\text{CN}_2\text{H}_4\text{O}$, by the controlled reaction of ammonia and carbon dioxide. The equation for this reaction is: $\text{NH}_3 + \text{CO}_2 \rightarrow \text{CN}_2\text{H}_4\text{O} + \text{H}_2\text{O}$. How much urea can be formed by the reaction of 105 g of ammonia, NH_3 , with 105 g of carbon dioxide?
4. Hydrazine, N_2H_4 , emits a large quantity of energy when it reacts with oxygen, which has led to hydrazine's use as a fuel for rockets: $\text{N}_2\text{H}_4 + \text{O}_2 \rightarrow \text{N}_2 + \text{H}_2\text{O}$. How many moles of each of the gaseous products are produced when 20.0 g of pure hydrazine is ignited in the presence of 30.0 g of pure oxygen? How many grams of each product are produced?
5. A group of students agreed to chip in the same amount for some lab equipment that would cost \$100. Then they found 5 more students interested in the equipment and in sharing the expenses. This decreased the amount each had to pay by \$1.00. How many students paid for the equipment and how much did each one have to pay?
6. Although they were formerly called the inert gases, at least the heavier elements of group VIII do form relatively stable compound. For example, xenon combines directly with elemental fluorine at elevated temperatures in the presence of a nickel catalyst. The equation for this reaction is: $\text{Xe} + \text{F}_2 \rightarrow \text{XeF}_4$. If 130. g of xenon is reacted with 100. g of fluorine and 145 g of XeF_4 are actually obtained, what is the per-cent yield for this reaction?
7. When a mixture of silver and sulfur is heated, silver sulfide is formed according to the following reaction: $\text{Ag(s)} + \text{S}_8\text{(s)} \xrightarrow{\Delta} \text{Ag}_2\text{S(s)}$.
- a) What mass of silver sulfide is produced from a mixture of 2.0 g of silver and 2.0 g of sulfur?
- b) What mass of which reactant is left unreacted?

*Relationship Between Fahrenheit and Celsius
Temperature Scales*

Introduction:

The Fahrenheit temperature scale is the scale of choice in the English system of measurement. The Celsius temperature scale is the metric temperature scale and is used in science. The relationship between the temperature measured in Fahrenheit (F) and the temperature measured in Celsius (C) is linear. The purpose of this exercise is to develop the equation for this relationship from experimental data.

Procedure:

You will be provided with a beaker of ice water, a hot plate, a Fahrenheit thermometer, a Celsius thermometer, and a sheet of graph paper. Measure the temperature of the water simultaneously in Fahrenheit and in Celsius over a wide temperature range. You should collect at least ten pairs of temperature readings. Record your results in a labeled table. Plot your points on a labeled and scaled set of axes on your sheet of graph paper. (Your axes should be labeled with C and F .) Draw the line of best fit and determine its equation. Show clearly how you developed this equation.

Chemath
Logarithm Exercise I

Sample
Homework
Problem Set

1. The number of fish an aquarium is given by $f = 8\log_5(2t + 5)$ where t is time in months. Find the number of fish present when:

a) $t = 0$

b) $t = 10$

c) $t = 60$

In problems 2 - 5, solve the equation for x .

2. $-\log_5 x = 2$

3. $\log_{16} x = \frac{3}{2}$

4. $-\log x = 2.1$

5. $-\log x = -4.2$

6. Find the Richter scale reading of the earthquake whose intensity is 1210 times greater than that of intensity of the smallest quake that can be measured on a seismograph.
7. The Mexico City earthquake of 1978 registered 7.85 on the Richter scale. How many times as intense as the smallest measurable quake was the Mexico City earthquake? How does this earthquake compare in intensity to the 1906 San Francisco earthquake, which measured 8.9 on the Richter scale?
8. In a particular solution, $[H^+] = 2.6 \times 10^{-4} \text{ M}$, what is the pH of the solution?
9. In a particular solution, $[H^+] = 4.72 \times 10^{-12} \text{ M}$, what is the pH of the solution?
10. In a particular solution, $[H^+] = 0.037 \text{ M}$, what is the pH of the solution?
11. If the pH of a solution is 6, what is $[H^+]$?
12. If the pH of a solution is 8.46, what is $[H^+]$?
13. If the pH of a solution is 0.62, what is $[H^+]$?
14. If the pH of a solution is 8.46, what is $[OH^-]$?
15. If blood's pH must be maintained between 7.35 and 7.45, translate this into $[H^+]$ range.
16. What does a pH of 0 mean?
17. The normal pH of the stomach is approximately 2. If a patient has a stomach pH of 1.35, how many times more acidic is his stomach solution?

Sample
College Bowl

Chemath Bowl Tournament

Rules

1. Three groups at a time will be selected to come to the front of the room.
2. A problem will be put on the board by Mary or David. A maximum of four minutes will be allowed to work the problem.
3. The first group to ring a bell will put the answer on the board.
4. If they answer correctly, that group will get 8 points. If the answer is not correct, that group will have 4 points deducted from their total score.
5. If the first group answers incorrectly, the other two groups will get an additional one minute to ring their bell and put their answer on the board.
6. If the next group who puts their answer on the board answers correctly, they will receive 4 points. If they answer incorrectly, they will have 2 points deducted from their total score.
7. If the second group does not give the correct answer, the third group will have the opportunity to put their answer on the board. If they answer correctly, they will receive 2 points. If their answer is incorrect, they will have 1 point deducted from their total score. If they choose not to answer, they will receive no points.
8. If none of the three groups chooses to put an answer on the board, no points will be awarded and the next three groups will be selected to start the process again with a new problem.

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